SYNOPSIS

Currently conventional sources like coal, petroleum and natural gas meet the energy requirements of developing and undeveloped countries. Over a period of time there is high risk of these energy sources getting depleted. Hence an alternate source of energy i.e. renewable energy is the need of the hour. The advantages of renewable energy like higher sustainability, lesser maintenance, low cost of operation, and minimal impact on the environment make the role of renewable energy sources significant. Out of the various renewable energy sources like solar energy, wind energy, hydropower, biogas, tidal and geothermal, usage of solar energy is gradually increasing. Among various solar energy sources, Photovoltaics has dominated over the past two decades since it is free clean energy and availability of abundant sunlight on earth.

Over the past few decades, thin film solar cells (TFSC) have gained considerable interest as an economically feasible alternative to conventional silicon (Si) photovoltaic devices. TFSCs have the potential to be as efficient as Si solar cells both in terms of conversion efficiency as well as cost. The advantages of TFSC are that they are easy to prepare, lesser thickness, requires lesser materials, light weight, low cost and opto-electronic properties can be tuned by varying the process parameters. The present study is focused on the fabrication of $AgInS_2$/ZnS heterojunction thin film solar cell. $AgInS_2$ absorber layer is deposited using both vacuum (sputtering/sulfurization) and non-vacuum (ultrasonic spray pyrolysis) techniques. ZnS window layer is prepared using thermal evaporation technique, detailed experimental investigation has been conducted and the results have been reported in this work. The thesis is divided into 6 chapters.

Chapter 1 gives general introduction about solar cells and working principle of solar cell. It also discusses thin film solar cell technology and its advantages. Layers of thin film solar cell structure, Significance of each layers and possible materials to be used are emphasized. A detailed overview of the available literature on both $AgInS_2$ absorber layer and ZnS window layer has been presented. Based on the literature review, objectives of the present work are defined.

Chapter 2 explains the theory and experimental details of deposition techniques used for the growth of $AgInS_2$ and ZnS films. Details of characterization techniques to study film properties are described in detail.

Chapter 3 presents a systematic study of $AgInS_2$ thin films deposited by sulfurization of sputtered Ag-In metallic precursors. Initially, $AgInS_2$ films are deposited by varying the substrate temperature and properties of as-deposited films are characterized. Structural, morphological, electrical and optical properties of $AgInS_2$ films are explained. From these studies, samples with better properties at particular substrate temperature are optimized. By fixing the substrate temperature, deposition time of silver is varied by keeping other deposition conditions same and the properties of films are discussed. It was observed that deposition time of silver doesn't have much impact on structural properties of $AgInS_2$ films. However, opto-electric properties of $AgInS_2$ films are enhanced. Based on characterization studies, deposition time of silver is optimized. Deposition time of indium is varied by keeping substrate temperature and silver deposition to optimized value. The properties of as-deposited films are discussed. Based on the above studies, the optimized p type films have a band gap of 1.64 eV, carrier concentration of 10^{13} ions/cm^3 and Resistivity of order 10^3 Ω-cm.

Chapter 4 presents a systematic study of $AgInS_2$ thin films deposited by ultrasonic spray pyrolysis. $AgInS_2$ films are deposited by varying the substrate temperature and properties of as-deposited films are characterized. Structural, morphological, electrical and optical properties of $AgInS_2$ films are explained. From these studies, samples with better properties at particular substrate temperature are optimized. By fixing the substrate temperature, concentration of silver molarity in the precursor solution is varied by keeping other deposition conditions same and the properties of films are discussed. Structural, optical and electrical properties of $AgInS_2$ films are enhanced with the increase in silver concentration. Based on characterization studies, concentration of silver is optimized. Similarly concentration of indium molarity in the precursor solution is varied and the properties of as-deposited films are discussed. Finally, sulfur molarity in the precursor solution is varied and properties of films are discussed. It was observed that increasing sulfur after certain limit does not have any effect on the properties of the films. Based on the above studies, this method resulted in the films with resistivity of 10^3 Ω-cm and band gap of 1.64 eV. These films showed a carrier concentration of 10^{13} ions/cm^3.

Chapter 5 describes the growth of ZnS films using thermal evaporation technique. Influence of thickness on the properties of ZnS films is explained. Samples with good crystallinity, high transmission, and wider gap are selected for device fabrication. This p type layer showed a band gap of 3.52 eV. Solar cells have been fabricated using the $AgInS_2$ films developed by both sputtering and ultrasonic spray pyrolysis techniques. A maximum cell efficiency of 0.92 percent has been achieved for the cell with 0.950 µm thick sputtered $AgInS_2$ layer and thermally evaporated 42 nm thick ZnS layer. In comparison, the ultrasonic spray pyrolysis deposited films gave an efficiency of 0.54 percent. These values are comparable to those mentioned in a couple of reports earlier.

Chapter 6 summarizes the conclusions drawn from the present investigations and scope of future work is suggested.